Big Boss Fiber System

System Elements
Requirements
Concepts

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Big Boss Fiber System

- **A close-packed focal-plane array of 5000 actuated input ends**
- **A fiber run from the focal plane to the spectrographs,**
- **Fiber slit assemblies (10 x) arranged into spectrograph slits of 500 fiber each**

<u>Actuator termination</u>

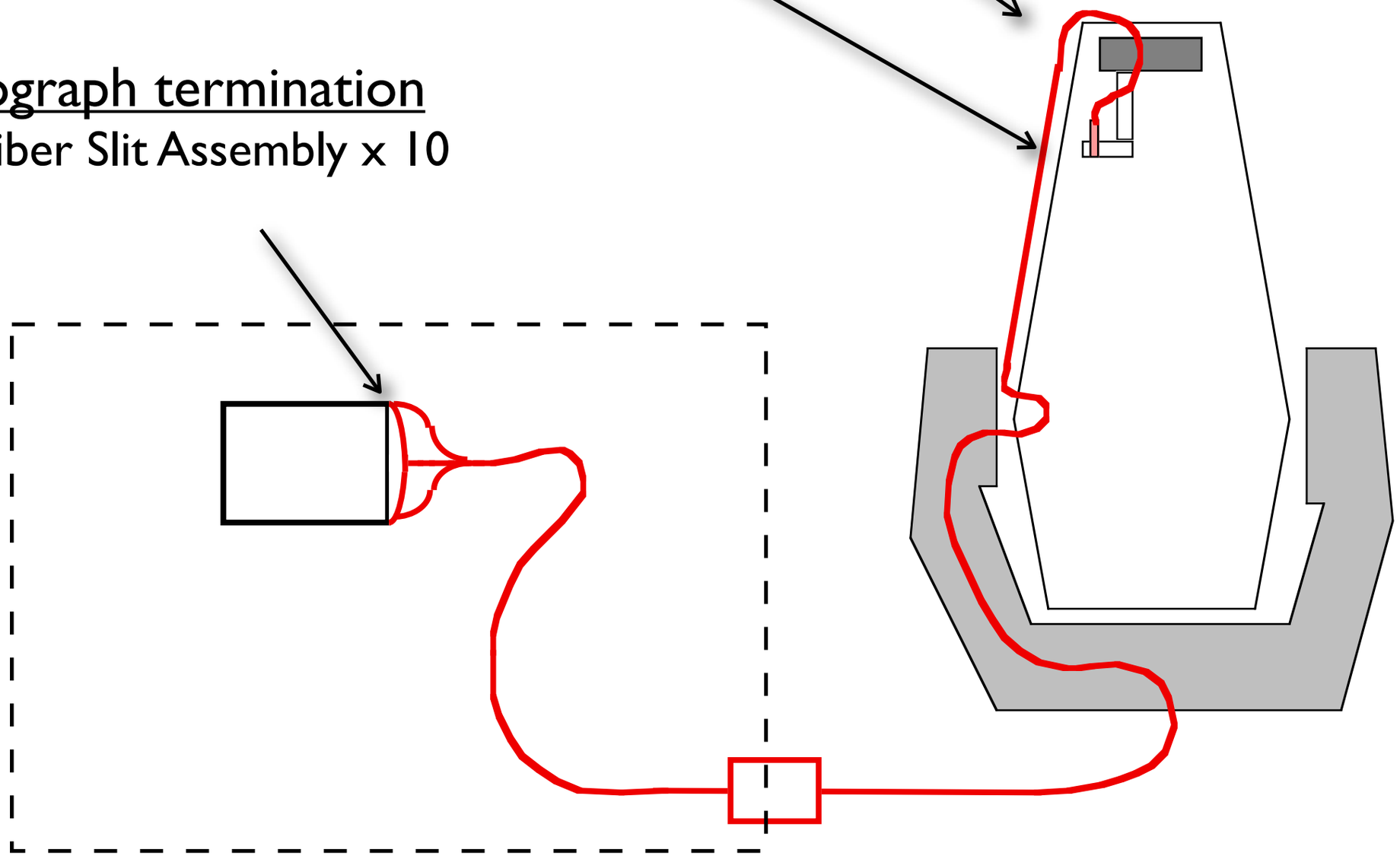
One of 5000 Fiber ferrules

<u>Routing / Support</u>

Focal Plane
Dec. & R.A. Yoke
Spectrograph Room
Fiber Connectors

<u>Spectrograph termination</u>

500 Fiber Slit Assembly x 10



Fiber System Requirements

Fibers

5000 each

~30 m length

Low OH fused silica (340-1060nm):

Bulk spectral transmission @ TBD %

Core 120 um diameter

FRD energy profile within f/4.0 for f/4.5 input @ telescope pupil

Fiber construction

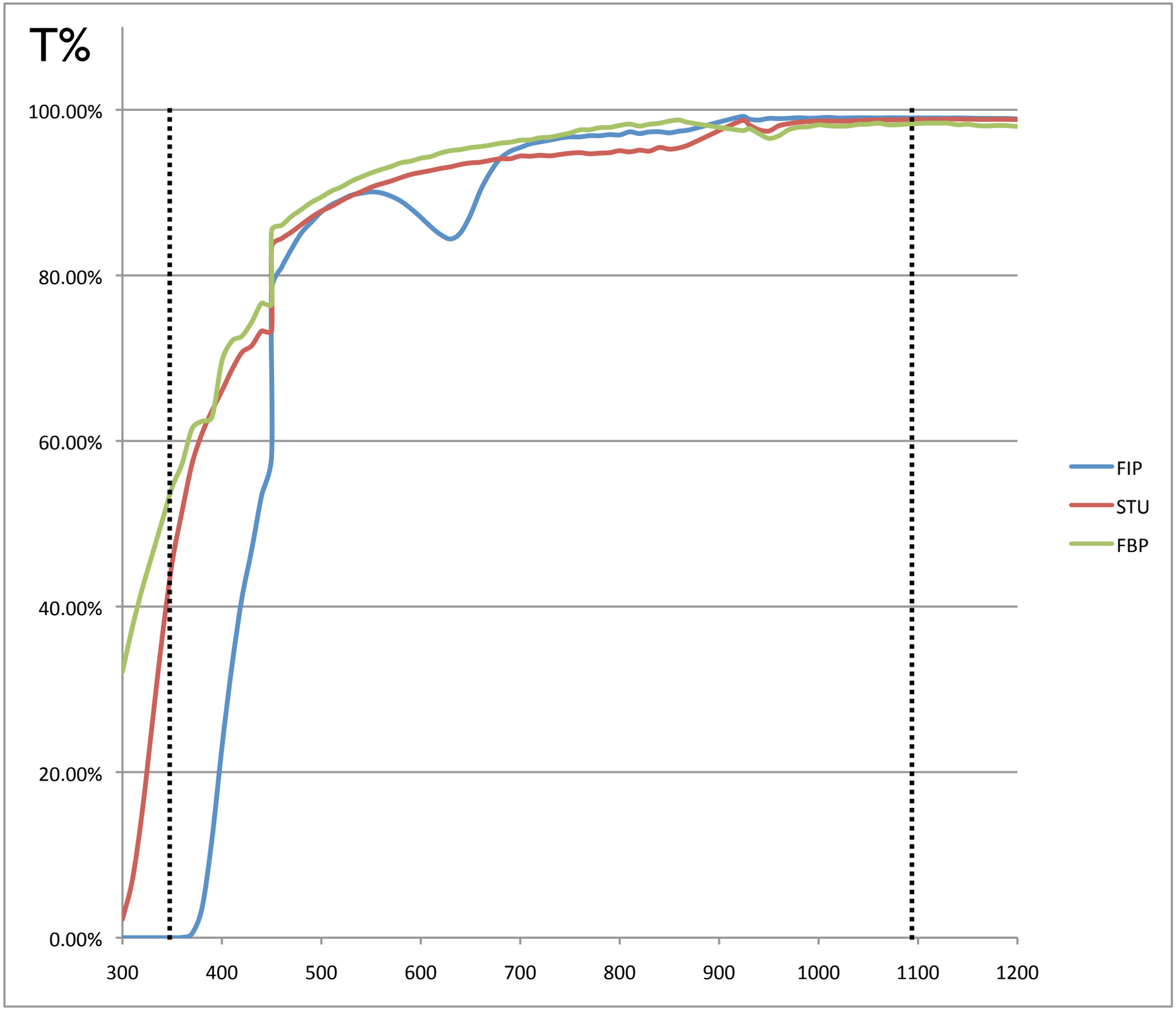
Cladding and jacketing combined outside diameter < 250 um

Actuator Fiber flexing: bending & twisting angles @ Nx15k cycles

Telescope Bundle flexing: bending & twisting angles " "

Polymicro

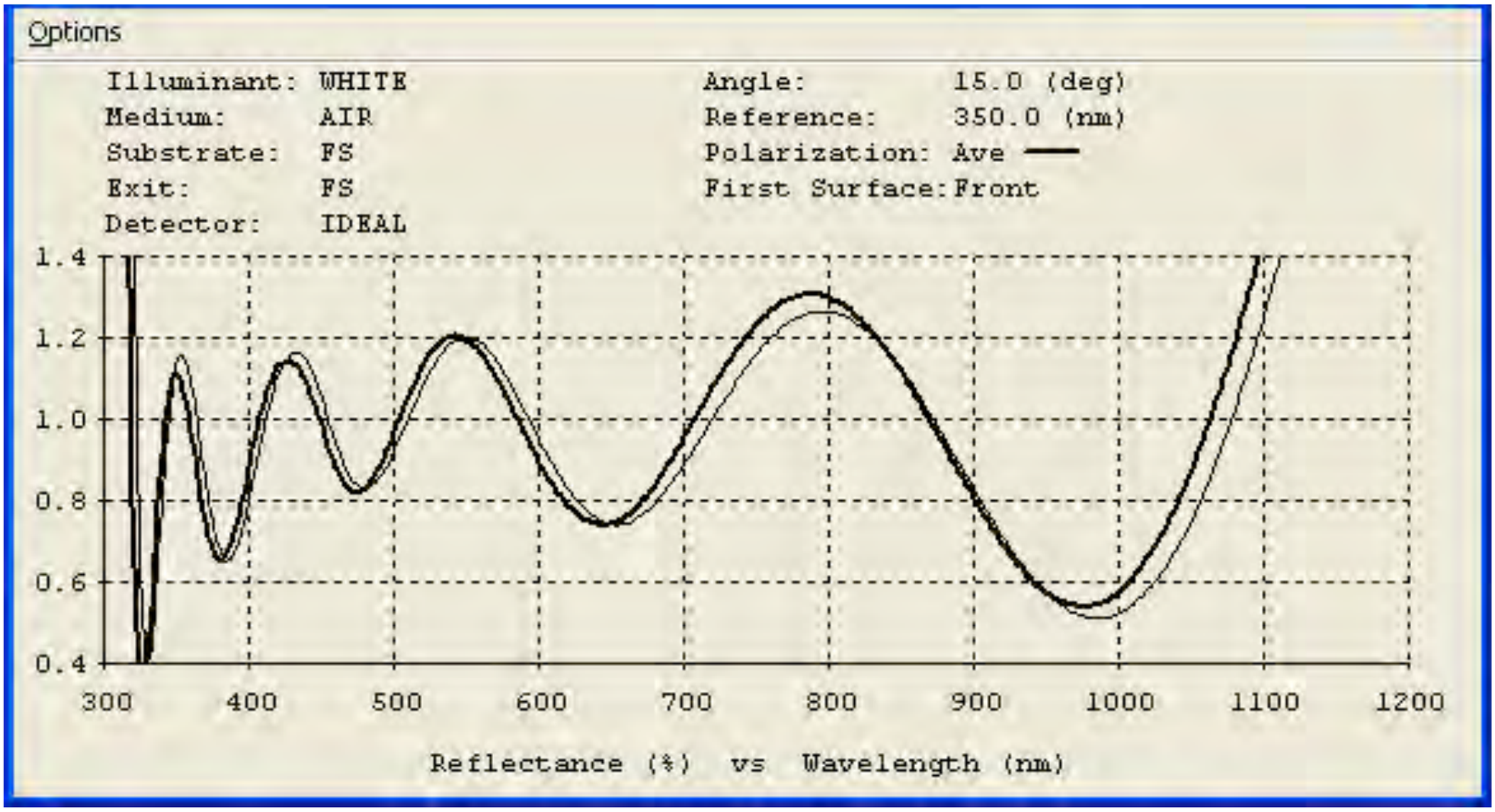
30m



FBP

Throughput: End finish AR coating

AR Coating per end yields ~1% loss
Coat direct to fiber ends (post glue & polish)



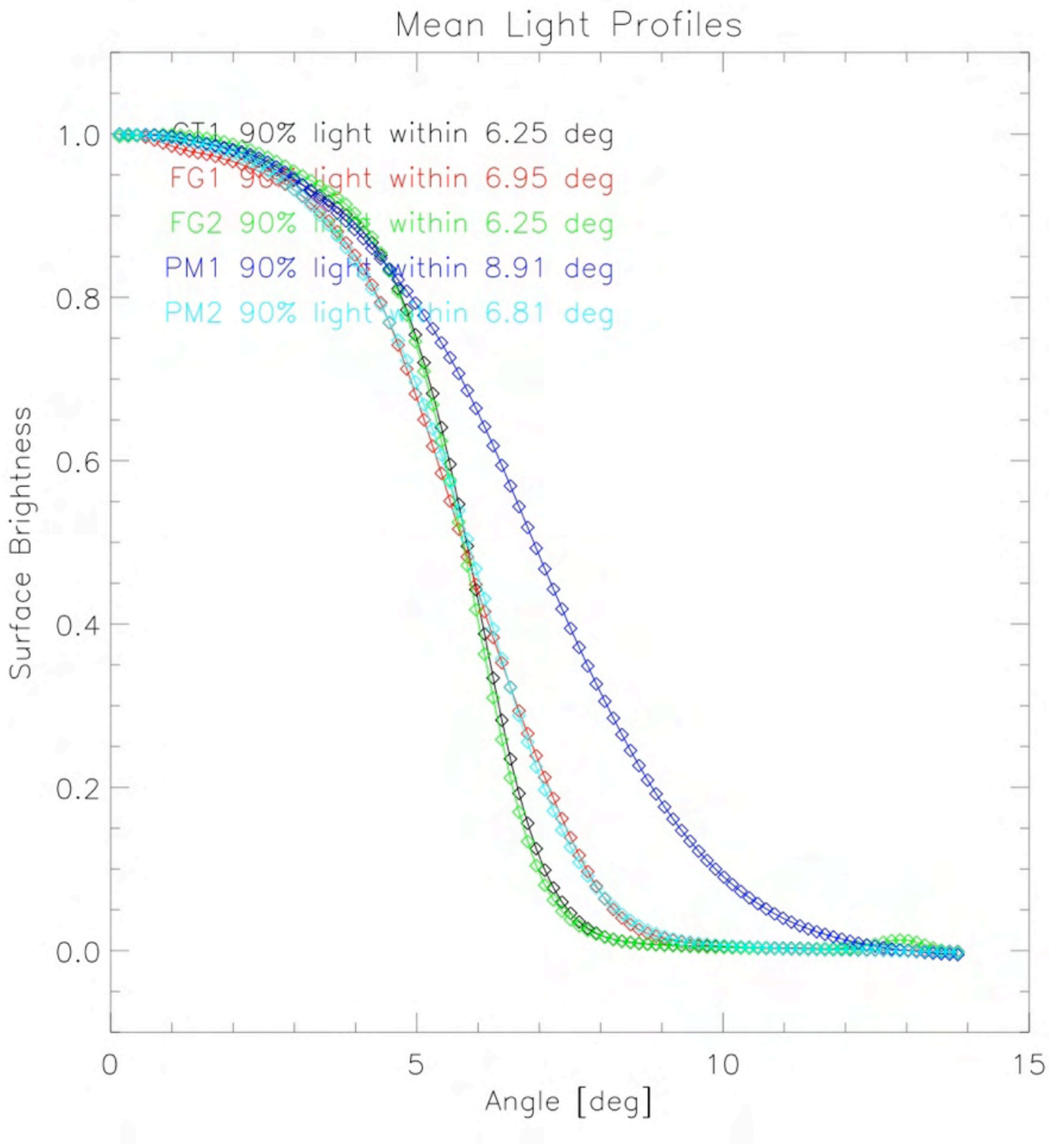
Modeled AR coating at 0 & 8 deg. incidence (by Polymicro on FBP).

FRD

Grasp degradation
f # out / f # in < 1

Mfg. run dependent
Degraded by stress
- Fiber end finishing
- Fiber support
- Fiber bending

Plan
- f/4.5 input
- f/4.0 output
- fiber output angular tol.
- fiber selection



FRD of Polymicro FBP 120 um core fiber measured for BOSS.

JE, UCB 16 Feb 10

Opto-Mechanical

Fiber construction

Core & Cladding:

clad ratio 1.1 (to 1.2 for IR)

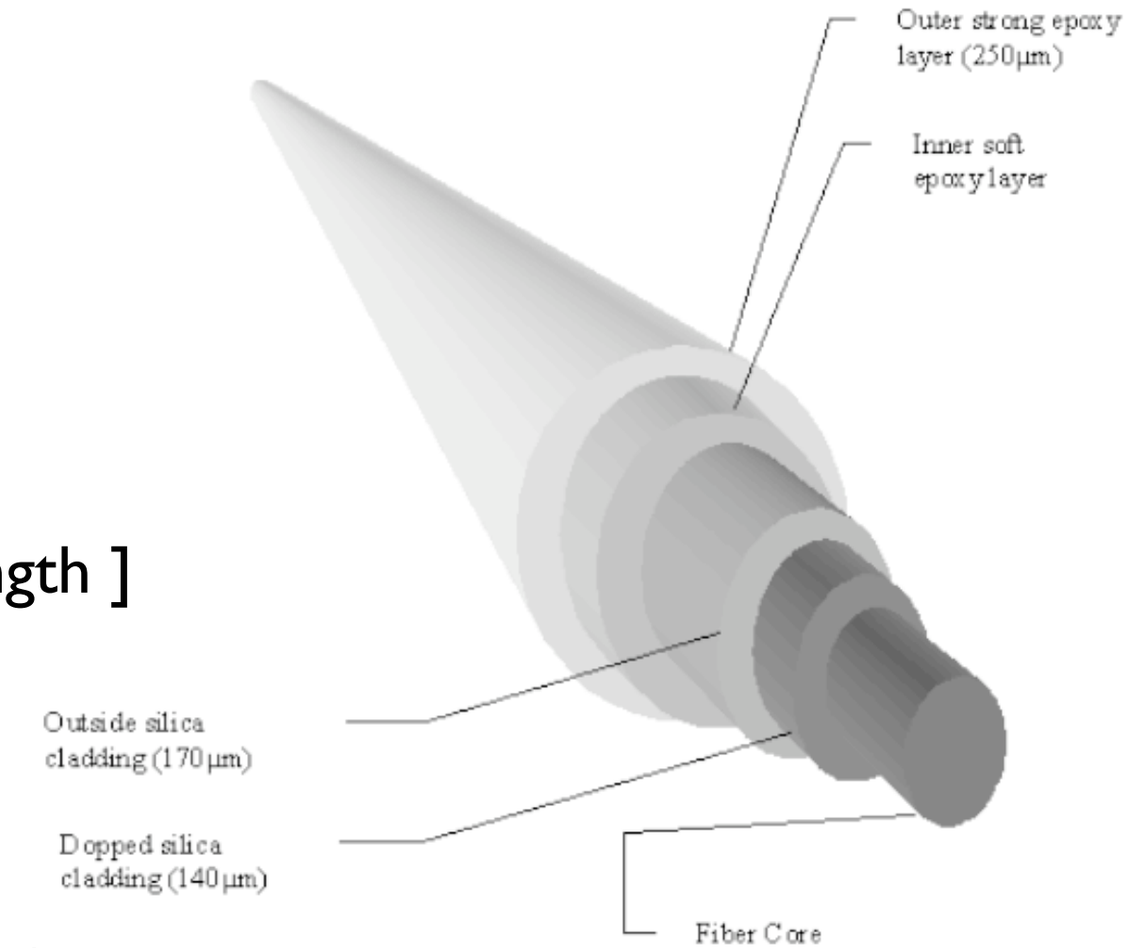
[secondary soft cladding for strength]

Coating

hard (e.g polyimide)

vs.

soft & hard coating (epoxy or acrylic)



Prieto, 2000 VIRMOS

A double layer of cladding
is then applied. The first one is doped silica,
and the second one is pure silica giving robustness to the fiber

External coating an epoxy [or acrylic] double layer coating
The central layer is soft and prevents stress on the fiber,
while the outer one is strong and gives robustness to assembly

Fiber System Requirements

Fiber Input End Assy

Flat faced

AR coated (350-1060nm) < 1.5% loss

Ferrule terminated, removable

Ferrule axial position accuracy in actuator (focal plane budget)

Fiber end angle +/- 0.5 deg (FRD budget)

Ferrule radial position accuracy in actuator

Significant temperature variation, e.g -20 to 35 C

Low stress design for fiber survival and FRD stability

- Ferrule material, process & design
- Glue selection, gap & bonding conditions
- End polishing
- Jacket termination
- AR Coating

Fiber Actuator Termination

MM LC Zirconia
Stick ferrule,
1.25mm 140um ID Bore
(MM-FER2007C-1400)

Minimize compressive stress = FRD changes

- Thermally matched ferrule
- High compressive strength
- = Ceramic ferrule tube
  - Bond, cleave, polish, AR

Actuator joint (metal)

- Clamp (replaceable)
- Precision axial re-location

Fiber System Requirements

Fiber run

Length ~ 30 m

Sub-bundle units (fiber blocks) for routing & maintenance

Robust bundle construction, support & routing

flex testing life 500 nights X factor

Mid-run Coupling connector for installation & maintenance

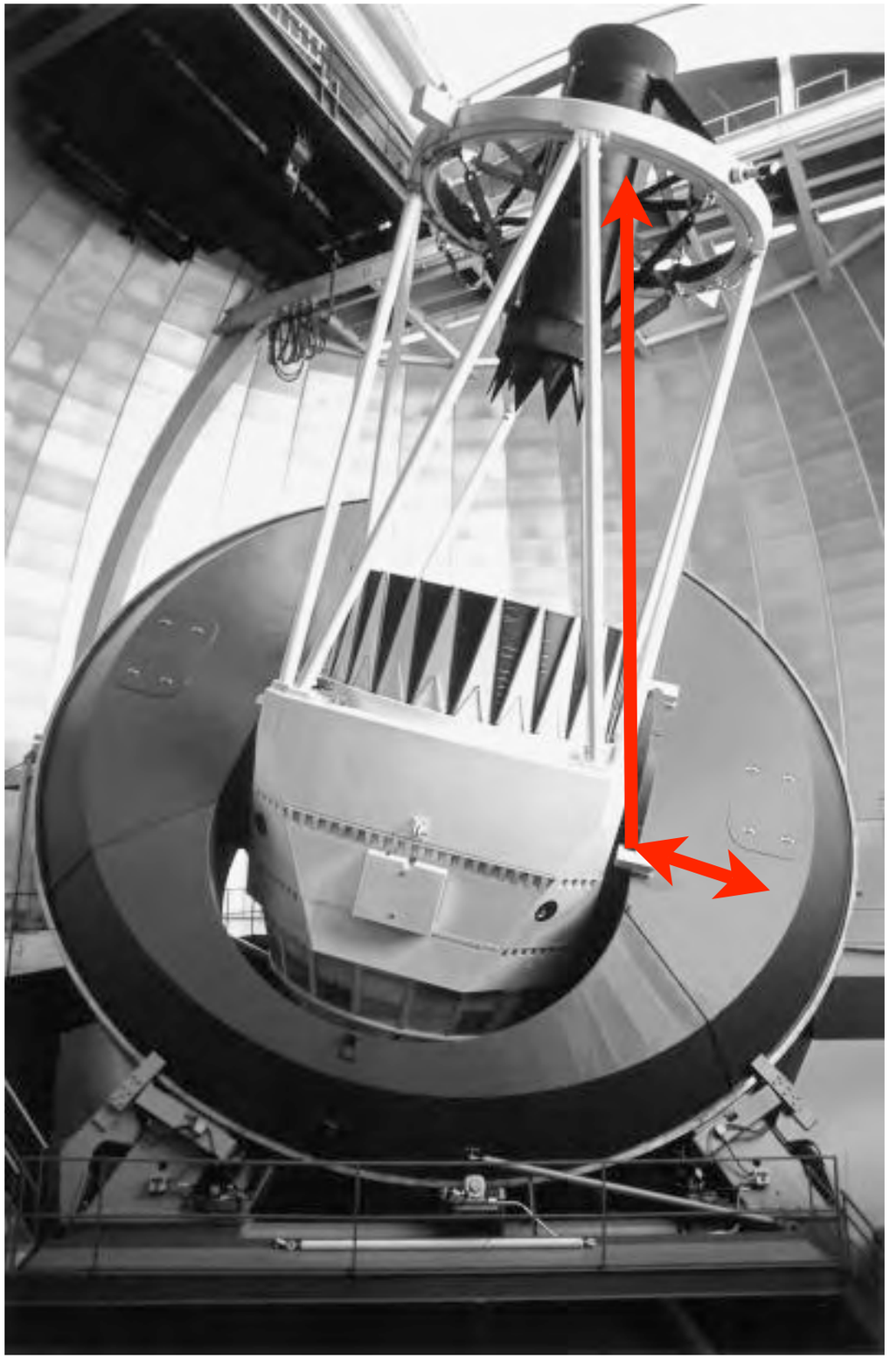
~ 100 fiber per connector

< 2% loss

in controlled (enclosed) environment

mate tested life 100

Fiber run & support



30 + meters

Focal plane to El. mount
Elevation mount rotation scheme
limited clearance
Elevation mount to Polar bearing
Polar mount rotation scheme
Polar mount to spectrograph run

JE, UCB 12 Jul 10

Fiber run & support

Mass

Fiber Core, Clad, Jacket	0.1 kg/m
PVC + Nomex per 100	0.25 kg/m
	0.35 kg/m total
	~20 kg bundle

Bundle construction

anti-torsional windup
installation & hang pulling strength
+Kevlar runners +Kevlar sleeve

Supporting Link-trays & spools & tensioners

Telescope facility dependent

Routing / pass-through

> Facilitate Focal Plane assembly delivered with fibers in place
> Rout cables through telescope to Spectrograph room

Serviceability

Allowed % fiber or actuator loss

Planned maintenance break for fiber/motor & spectrograph service

Routing aperture sizes

=> 2.5 x 10 x 1 cm Fiber Block fit ?

Focal Plane
+ fiber jacket / sleeve start
Dec. Yoke
RA Yoke
to Spectrograph Room

Mulit-ganged connector breaks

e.g. US Conec w/ index gel

Thermal & contamination issues

Fiber System Requirements

Slit Array Assembly

500 fibers per slit assembly

134 mm tall

400 mm radius of curvature

curved fiber face

Fiber ends within 100um of radius of curvature

Mechanical interface & registration

Fiber back illumination

“Leaky Fiber adjacent”

Continuum spectral requirements for ‘flat field’

Fiber slit assembly concept

Slit Assembly including 5 ea. Fiber blocks

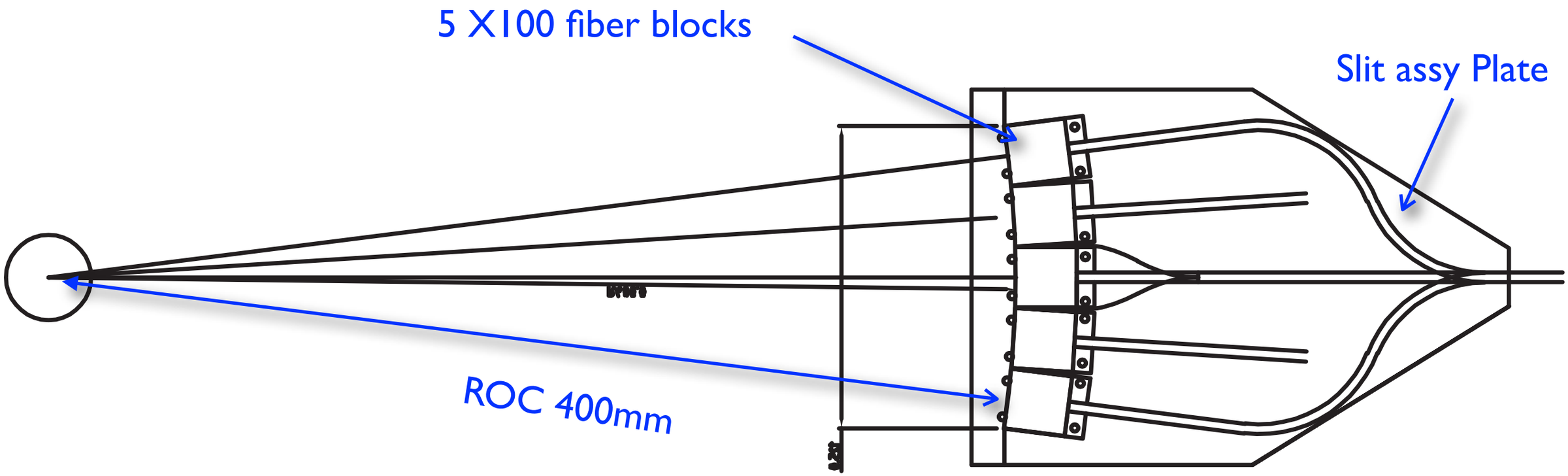
Fiber Block @ 100 fibers @ 250 um spacing = 25 mm

Bond 100 fibers, polish, inspect, AR coat

Blocks precision located on Slit Assembly with pins

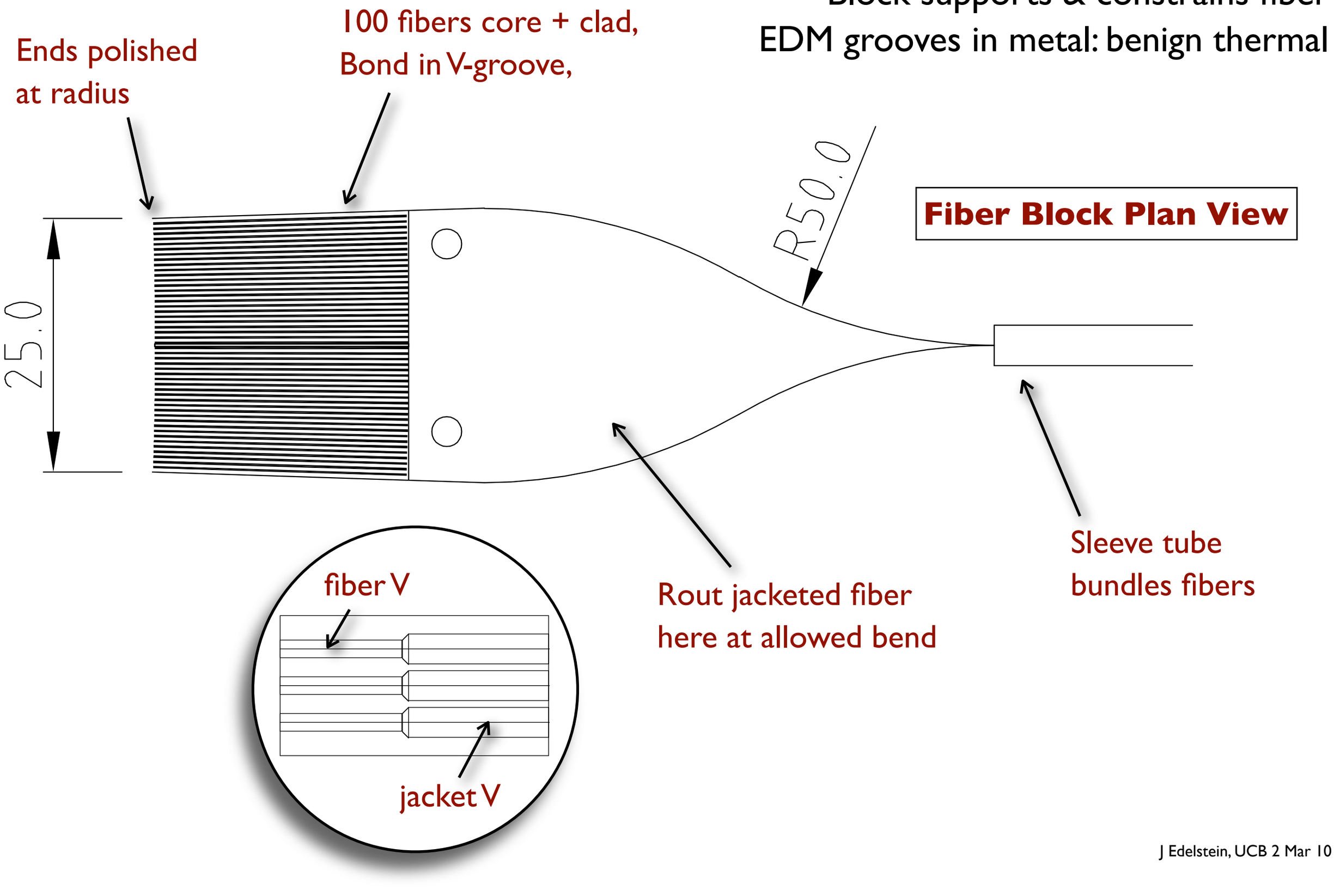
Slit Assembly precision locates to spectrograph

Slit Assembly supports & constrains fibers motion



Slit Assy Fiber Block concept

Fibers bonded to V-groove
Continuous pupil angle variation
Block supports & constrains fiber
EDM grooves in metal: benign thermal

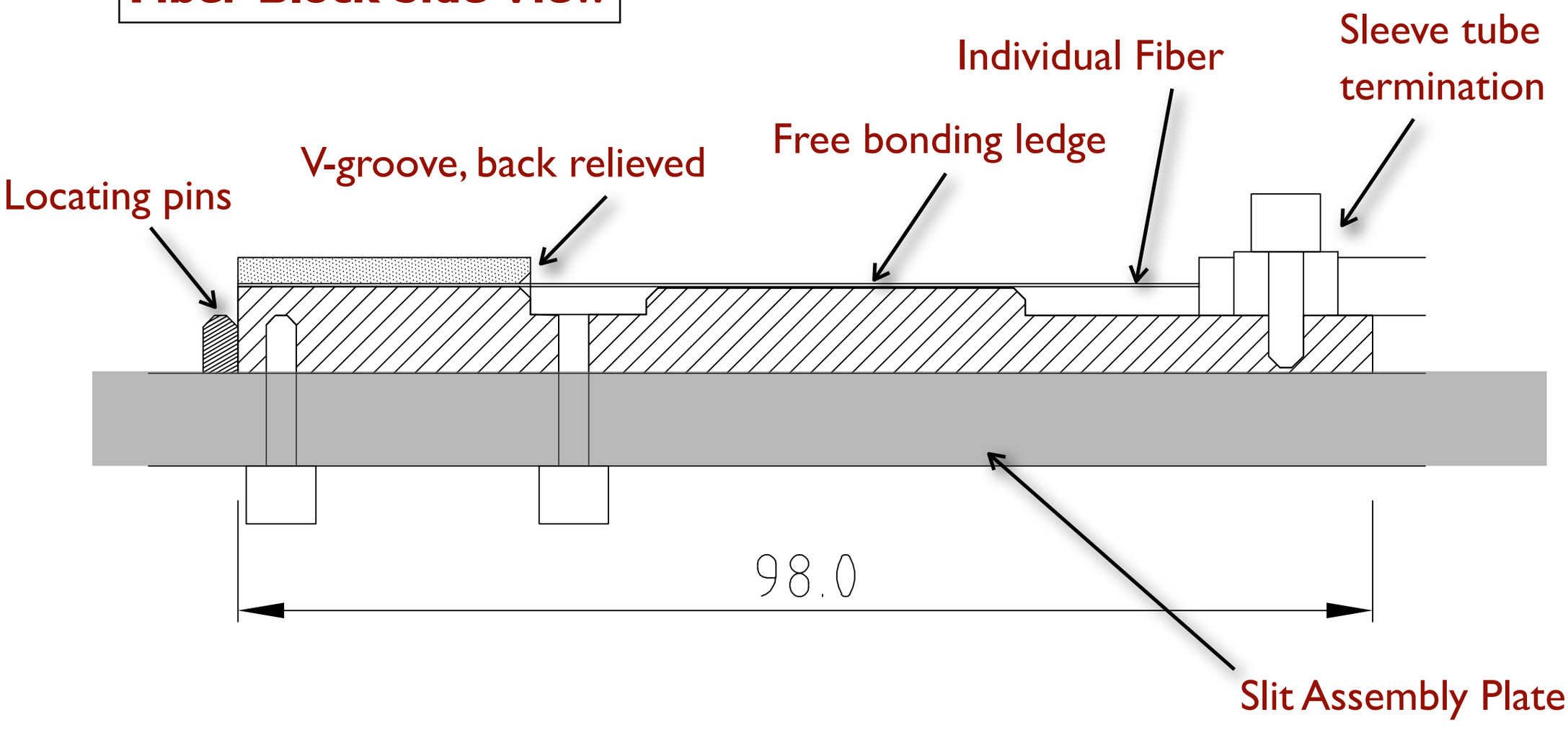


Fiber Block concept

5 X 100 Fiber blocks per Spectrograph Slit

Blocks precision located with pins on support plate

Fiber Block Side View



Key Interface Definitions

Actuator fiber interface

Focal plane actuator/fiber access & routing

Spectrograph slit interface & requirements

Telescope & Facility bundle routing interface

Development

IEU BCCP Fiber Testing Team
Fiber Test Program

Ewha Woman's University
IEU (Institute for Early Universe)

Phase I: Development

Test critical performance parameters
Survey and evaluate techniques & vendors
Test facility development

Throughput
Focal Ratio Degradation (FRD)
Termination Methods
Bundle construction
Fiber and bundle fatigue

Phase II: Production

Science fiber production
Performance verification